Plasma Jet Printing Technology for In-Space Manufacturing and In-Situ Resource Utilization, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

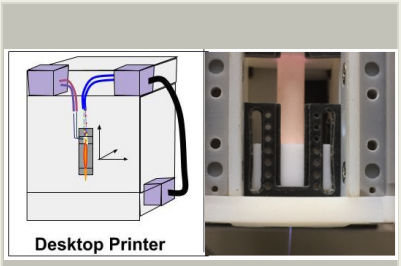
Manufacturing technologies that can embed structural electronics into objects built at destination are being explored by NASA's Next Space Technologies for Exploration Partnerships (NextSTEP). Direct write printing technologies play a key role in the fabrication of next generation of printed electronics products. Compatibility of multi material printing technology with in-situ resource utilization (ISRU) and in space manufacturing (ISM) is challenging. The need for multiple tools for printing and processing different sets of materials will increase the payload, occupy large space and consume more resources in ISS, all of which are undesirable.

Space Foundry is developing a plasma jet based direct write printing technology to enable printed electronics fabrication in space with reduced processing steps. Plasma jet provides the ability to deposit conductive patterns, insulators, dielectric materials, and semiconductors with precise thickness control and tunable material properties. The material to be printed is aerosolized and focussed using electromagnetic field and plasma that provides directional printing and this electric field controlled directionality makes it a highly suitable technology for operating in micro-gravity environment. The overall objective is to develop a robust plasma jet print head with precision machining of the nozzle for space use, integrated fluid delivery module and miniaturized power supply. The bench top prototype system at TRL level 6 will successfully demonstrate the feasibility of the technology for independent operation at earth and in space. Plasma jet technology has cross cutting applications in sterilization, organics decontamination, water treatment, bioprinting etc., The plasma jet technology offers a unique value proposition to NASA mission needs as it drastically reduces the process steps and eliminates the need for multiple equipment sets.

Anticipated Benefits

Technologies that will enable in-situ resource utilization (ISRU) and ISM are needed to reduce the crew dependency on Earth and resupply missions. The overall objective of the phase 1 work is to take the first steps towards printed electronics manufacturing on Mars, while immediate use is envisioned for Earth and ISS. Some of the ISM applications of the technology are on-demand fabrication of energy storage devices, gas sensors, bio sensors, interconnects, RF antenna and additive manufacturing.

Printed electronic devices including flexible electronics and flexible hybrid electronics are nextgeneration internet of things connected smart devices that have applications in both consumer and industrial segments. The printed electronics equipment market is $1.5B and consumables market is over $4B and growing at a CAGR of 22%. The plasma jet printing represents a paradigm shift in performance and capability and aims to disrupt the printed



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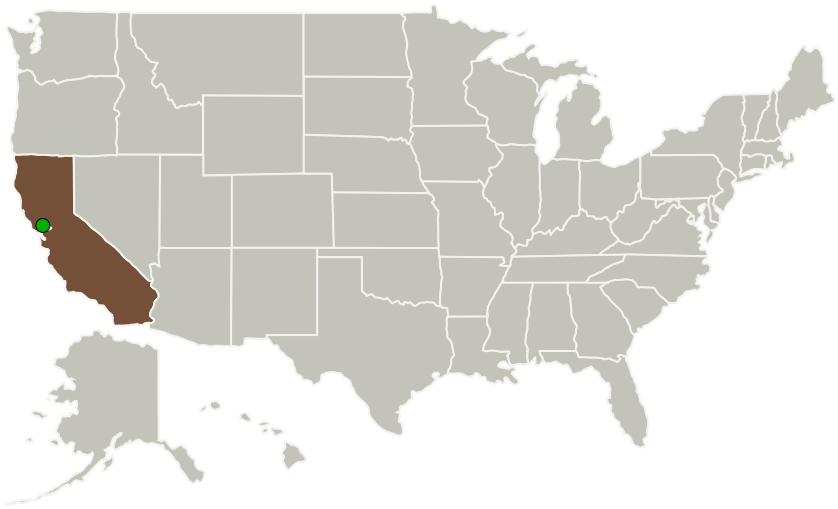
electronics equipment and consumables industry.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Space Foundry, Inc.	Lead Organization	Industry	Sunnyvale, California
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations
California

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141228)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Space Foundry, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

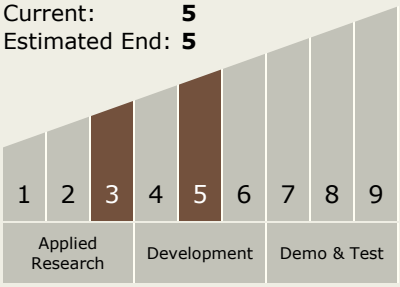
Carlos Torrez

Principal Investigator:

Ramprasad Gandhiraman

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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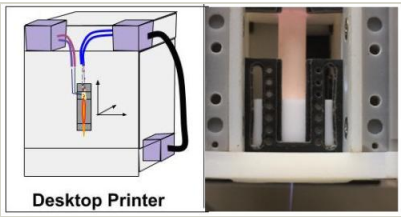
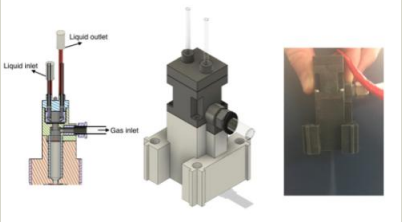
Images



Briefing Chart Image
Plasma Jet Printing Technology for In-Space Manufacturing and In-Situ Resource Utilization, Phase I
(https://techport.nasa.gov/image/132061)



Final Summary Chart Image
Plasma Jet Printing Technology for In-Space Manufacturing and In-Situ Resource Utilization, Phase I
(https://techport.nasa.gov/image/126974)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.2 Mission Infrastructure, Sustainability, and Supportability
    - TX07.2.2 In-Situ Manufacturing, Maintenance, and Repair

Target Destinations

Earth, The Moon, Mars